PWA
PHILIP WILLIAMS & ASSOCIATES, LTD
ENVIRONMENTAL HYDROLOGY
550 Kearny Street, Suite 900
San Francisco, California 94108-2404
TEL 415.262.2300 FAX 415.262.2303
www.pwa-ltd.com

MEMORANDUM

Date:	August 17, 2010
To:	Pierre Martinez and Paul Marshall (CEC)
CC:	Jim McLucas and Greg Lamberg (Radback)
From:	Mark Lindley, PE and Philip Luecking, PE
PWA Project:	Oakley Generating Station (# 1835.10)
Subject:	**Stormwater Management Plan Review**

This memorandum provides a review the proposed stormwater management plan for the Oakley Generating Station (OGS). The project Applicant provided updated plans, calculations and documentation for stormwater management in response to queries made by Staff (Mark Lindley) during the Data Response and Issue Resolution Workshop held on April 23, 2010. Staff requested this additional information in an effort to ensure that the stormwater management plans proposed by the Applicant will meet the requirements of the NPDES Permit, Contra Costa County, and the City of Oakley. Staff has reviewed the revised plans and back up calculations and has summarized the plan, comments, and recommendations in this document to help facilitate the development of a stormwater management plan that will meet the necessary design requirements and mitigate potentially significant impacts.

This memorandum specifically addresses the concerns expressed by Staff and responses provided by the Applicant relating to the following items:

1. Flood control – The proposed project must limit increases in discharge from the project site to meet flood control standards and to limit impacts to downstream properties associated with development of the project site. The project proposes contain all runoff within Wetland E and other onsite detention facilities with no offsite discharge.

2. Wetland E – The proposed project plans to discharge all stormwater runoff to Wetland E, an existing mitigation wetland in the northwest corner of the site. Wetland E has no outlet and currently captures runoff from the project site and adjacent PG&E switchyard. To limit impacts to the hydrologic function of Wetland E, the proposed stormwater management plans must limit changes in delivery of runoff to Wetland E. In particular, the Applicant needs to demonstrate that the proposed stormwater Best Management Practices will not impede the delivery of runoff to Wetland E through capture and infiltration during small, typical rainfall events.

3. Water Quality Treatment – The proposed project needs to meet (or exceed) the minimum water quality treatment standards required by Contra Costa County under the County's NPDES Permit issued by the Regional Water Quality Control Board. Since the proposed project plans to

discharge all runoff to Wetland E, adequate water quality treatment is particularly important to limit the discharge and concentration of pollutants in Wetland E.

PROPOSED STORMWATER MANAGEMENT PLAN

The Applicant provided a revised design and stormwater plan in the *Response to CEC Staff Workshop Queries 3 through 17*, dated July 2010. This document includes narrative and figures that describe the proposed stormwater features as well as supporting design calculations and modeling results in response to the workshop queries.

The existing 25-acre site drains overland to Wetland E at the northwest corner of the project site. Wetland E is a 0.62 acre mitigation wetland located within a 1.6 acre conservation easement granted by the California Department of Fish and Game (CDFG). The wetland has no outlet structure and historically flow to the wetland has not resulted in any surface discharge from the wetland. The site is currently primarily vineyard with some graveled area. Just south of Wetland E, there is a PG&E switchyard that includes gravel access roads and a number of small buildings and concrete surfaces.

The OGS project would reconfigure the site replacing the existing vineyard with buildings, pavement, gravel, and landscaping to develop a power plant. The proposed project would have an impervious area of about 5.4 acres or approximately 20% of the project site and compacted rock on about 8.2 acres or about 31% of the project site. This increase in impervious surface would result in increases in the peak flow rates and volume of stormwater runoff from the site. The stormwater management system aims to reduce potential impacts due to increases in peak flows and volumes by using stormwater features to capture, detain, and infiltrate these flows to a level less than or equivalent to existing conditions. Additionally, the OGS project is required to provide water quality treatment of the stormwater runoff generated by the project to protect Wetland E from water quality impacts.

The proposed stormwater management system is also intended to maintain the current function of Wetland E following construction of the OGS. The proposed stormwater management plan would direct surface runoff to four bioswales (linear bioretention) facilities for conveyance and water quality treatment and/or a detention basin (pond) prior to releasing the runoff to Wetland E. The proposed layout of these facilities is presented in Figure WSQ11-1. Each of the bioswales and the detention basin would have an outlet structure with a vertical standpipe. The outlet structures would discharge low flows via orifices and high flows via weir flow into the top of the vertical circular standpipe. The low flow orifices proposed for each of the bioswales would be about nine inches above the base of the swale. Two of the bioswales (#1-2 and #4) would discharge to the detention basin while the other two (#3 and #5) would discharge directly to the wetland. The proposed stormwater system is intended to:

- Capture and detain runoff such that there is no discharge from the wetland
- Maintain the existing function and hydrologic connection to Wetland E
- Provide water quality treatment for stormwater runoff

HEC-HMS Analysis

The Applicant developed HEC-HMS models to estimate the peak flow rates and runoff volumes for the pre- and post-construction site conditions. The models were used to evaluate the ability of the proposed stormwater system to reduce peak flow rates to the wetland to match existing conditions, to show that the wetland will not overtop during large runoff events, and to show that flows to the wetland would not be significantly reduced during small, frequent rainfall events.

The existing conditions model is comprised of a single discharge area (25.15 acres) with all flow directly to the wetland. The proposed conditions model is comprised of six drainage areas: (4 bioswales; pond; and wetland for a total of 26.3 acres. Model inputs included drainage area delineations by ground cover type, precipitation for Contra Costa County, and estimated time of concentration for the site. The analysis also includes an estimate of initial abstractions (losses) and an allocation of 1% impervious area to allow for a small increase in impervious area during final design. Elevation-area-discharge relationships were developed for each of the four bioswales and the detention basin. The discharge relationship is based on the proposed outlet structure configuration for each facility including rim elevation, standpipe diameter and an estimate of the governing outlet flow condition (weir or orifice). The low flow orifices were not included in the analysis for the peak flow estimates for the bioswales (WSQ8-2). The detention basin outlet structure includes a low flow orifice at Elevation 10.0 feet.

The peak discharge rate was estimated for the 100-year 24-hour, 10-year 24-hour, and one inch rainfall events under existing and proposed conditions. The analysis presented by the Applicant indicates that the proposed stormwater system would control the peak flow rates to the wetland to be equal-to or less-than existing conditions. The pre- and post-construction peak flow rates are summarized in Table 1.

A separate, volumetric analysis was conducted to determine if the runoff generated from the site would result in a surface discharge via overtopping of the berm adjacent to the wetland or significant changes in delivery of runoff to Wetland E. This analysis used the runoff volumes from HEC-HMS for the same three storm events as the peak flow analysis. Additionally, the 100-year + 10-year runoff event was modeled to represent an extreme condition based on guidance from Contra Costa County Public Works Department. The volumetric analysis was also used to demonstrate that runoff volumes from small, frequent runoff events would not be significantly altered by the proposed stormwater management plans.

Table 1. Pre- and Post-Construction Peak flow, runoff volume and wetland WSEL

	Pre-Construction			Post-Construction		
Rainfall Event	**Peak Flow (cfs)**	**Runoff to Wetland (acre-feet)**	**Wetland WSEL (feet)**	**Peak Flow (cfs)**	**Runoff to Wetland (acre-feet)**	**Wetland WSEL (feet)**
1-inch	0.1	0.03	5.1	0.1	0.05	5.1
10-year	3.2	1.10	7.2	3.1	1.51	7.7
100-year	11.8	2.70	8.9	9.1	3.58	9.7
100-year+ 10-year	-	3.80	10.0	-	5.42	10.7

Taken from Attachment WSQ6-1 and WSQ8.2

Flood Control – Applicant's Analysis

The Applicant utilized the HEC-HMS runoff volume results to demonstrate that the proposed detention basin combined with Wetland E would have adequate capacity to contain the 100-year + 10-year runoff volumes.

The proposed detention basin would have an invert elevation of 8.5 feet and include a storage volume of 0.33 acre-feet below the first orifice at elevation 10.0 feet. Under high stage conditions, the water surface elevation in the wetland and pond would eventually equalize across the connecting culvert to provide storage required for large runoff events. The elevation-area-storage of the equalized pond and wetland is presented in Table 2. The volumetric flood control analysis did not include any storage in the bioswales or account for infiltration, thus assuming that the total site runoff would reach the pond or wetland. The results of the analysis indicate that the pond and wetland can contain the runoff generated by the 100-year + 10-year event at a water surface elevation of about 10.7 feet with about 1 foot of freeboard below the 11.7 feet elevation of the low spot in the roadway berm adjacent to the wetland. The runoff volumes and corresponding water surface elevations in the wetland are presented above in Table 1.

Table 2. Equalized Wetland & Pond Elevation-Area-Storage

Elevation	Wetland Area (acres)	Pond Area (acres)	Incremental Wetland Storage (acre-feet)	Incremental Pond Storage (acre-feet)	Cumulative Storage (acre-feet)
5.0	0.40	-	-	-	-
7.5	0.62	-	1.28	-	1.28
8.5	0.95	0.18	0.78	-	2.06
9.0	1.11	0.21	0.52	0.10	2.68
10.0	1.44	0.26	1.28	0.23	4.19
11.0	1.55	0.31	1.50	0.29	5.98
11.5	1.60	0.34	0.79	0.16	6.93

Taken from Attachment WSQ6-1

Flood Control – Staff Review

Staff is generally in agreement with the methodology and inputs used to develop the HEC-HMS model for existing and proposed conditions that served as the basis for the peak flow (WSQ8-1 and WSQ8-2) and volumetric analyses (WSQ6-1). The precipitation data was modified to use rainfall estimated for Oakley and Contra Costa County which satisfies the information requested as workshop query WSQ12. The assumption that all runoff would ultimately be discharged to the proposed detention basin and Wetland E is conservative for flood control purposes. In reality, some runoff would be captured and infiltrated within the bioswales reducing the total runoff delivered to the Pond and Wetland E.

The volumetric capacity analysis indicates that the wetland and detention basin have sufficient capacity to contain all of the runoff generated from the OGS site for a 100-year + 10-year storm event. Contra Costa County directed the Applicant to size the detention basin to contain the 100-year storm event without discharge. Additionally, they recommended the Applicant evaluate the 100-year +10-year event with an empty basin initial condition. This approach satisfies information requested in workshop query WSQ10.

The equalization estimate shows that there is sufficient storage capacity in the two features to allow for water surface equalization. The volumetric based determination of the water surface elevation in the wetland resulting from the 100-year +10-year event results in a water surface elevation of 10.7 feet, which is one foot below the low spot in the adjacent berm.

However, Staff would like to see the HEC HMS modeling revised to better account for directly connected

impervious surfaces. The Applicant combined impervious surfaces with pervious surfaces to determine a composite Curve Number for each drainage area. While this approach is acceptable for areas were impervious surfaces drain across pervious surfaces, it can lead to under-estimation of peak flow rates and runoff volumes for areas where impervious surfaces discharge directly to catch basins and stormdrain pipes as proposed at the Oakley Generating Station. The HEC-HMS inputs should be revised to reflect the portion of the impervious surface that discharges directly to the proposed stormdrain system.

Ideally, the proposed detention basin can be expanded if needed to account for any increases in runoff volumes while maintaining the Applicant's conservative analysis assumptions to demonstrate flood control compliance.

The City of Oakley would ultimately provide review and comment on the onsite stormwater facilities and may request additional analyses as part of the final design. Staff recommends that the Applicant conduct a hydraulic analysis of the detention pond outlet structure and the connection to the wetland to ensure that the system will perform hydraulically as anticipated.

Wetland Hydrology – Applicant's Analysis

The Applicant has committed to the California Department of Fish and Game in the Wetland E Management Plan that the proposed stormwater management plan for OGS will maintain the existing water quality and hydraulic flow to Wetland E. To demonstrate that the hydrologic function of the wetland will not be significantly altered, the Applicant used the HEC-HMS runoff volume results for a 1-inch rainfall event to compare pre- and post-construction hydrologic conditions. The Applicant's runoff volume results assumed that all runoff delivered to the bioswales would be discharged to the pond and/or wetland and neglected to account for capture and infiltration or flow through the low flow orifices. The Applicant's modeling results, indicate that the proposed system will continue to deliver runoff to the existing wetland following construction of the OGS. The peak flow rates to the wetland would be reduced but the total volume of stormwater delivered to the wetland would increase as shown in Table 1.

Wetland Hydrology – Staff Review

It is a requirement of this project to ensure that the existing mitigation wetland is not adversely affected by construction of the OGS. It is important that the Applicant be able to show how runoff resulting from small runoff events will reach the wetland under proposed conditions. Staff has reviewed the Applicant's assumptions, and has several significant concerns about the analysis presented by the Applicant to demonstrate no significant change to the hydrology of Wetland E:

1. The proposed outlet structures for each bioswales include low flow orifices set at 9 inches above the base of the swale. This proposed configuration would result in capture and infiltration of the first 0.22 acre-feet of runoff from the project site. However, the Applicant's analysis neglected to account for capture and infiltration of runoff in the proposed bioswales. Based on the results provided by the Applicant, it appears that runoff to the wetland may be reduced by about 67% during rainfall events of 1-inch or less if capture and infiltration were included in the analysis. The modeling should be revised to reflect the elevation of the low flow orifices and infiltration of runoff detained within each bioswale. Alternatively, the Applicant could propose low flow orifices that do not result in significant capture and infiltration of runoff. Ideally, the swales would be designed as flow based BMPs with orifices sized to pass the water quality flow rate to limit capture and detention.

2. Similar to the bioswales, the proposed detention pond would capture and infiltrate the first 0.33 acre-feet of runoff. However, given the proximity of the Pond to the wetland, the impact of this capture and infiltration may be mitigated to some extent by sub-surface flow from the pond to the neighboring wetland.

3. The impervious areas within the PG&E switchboard complex do not appear to have been included in the composite Curve Number calculations for the existing conditions watershed. These areas may be considered directly connected to the wetland depending upon how close the buildings and concrete surfaces are to the wetland. Updating the model inputs would result in an increase in estimated runoff reaching the wetland under existing conditions.

4. The directly connect impervious area should be reflected in the HEC-HMS input files as discussed above under flood control.

Water Quality Treatment – Applicant's Analysis

The proposed stormwater management plan includes four bioswales to provide water quality treatment for the OGS project. The Applicant developed the design for the proposed bioswales based on the procedure for Low Impact Development (LID) and Integrated Management Practices (IMP) set forth in the Contra Costa Clean Water Program (CCWP) *Stormwater C.3 Guidebook* (C.3 Guidebook). Provision C.3 of the RWQCB NPDES permit for new and redevelopment requires minimization of impervious areas; protection from sources of stormwater pollutants; treatment prior to discharge from the site; runoff less than or equal to pre-project peaks and durations; maintenance of treatment and flow-control features (CCCWP, 2008). The CCCWP developed a LID approach to meet these requirements and the C.3

Guidebook provides a methodology to ensure consistent implementation of the C.3 requirements. The Applicant selected Option 2: Implement IMPs for the LID design approach for treatment and flow control.

The C.3 Guidebook provides sizing factors for selected IMPs and hydrologic soil groups. The entire project is located in Hydrologic Soil Group A. These sizing factors in addition to surface conditions for each drainage area were used to estimate the minimum surface area and treatment volume required for each IMP.

The OGS project would use bioswales (described in the C.3 Guidebook as linear bioretention facilities) for the IMPs. The Applicant sized the four bioswales to meet the minimum surface area and treatment volume design criteria. The design criteria are used to size and IMP to meet the treatment requirement by capturing the treatment volume over a required minimum treatment area. The proposed detention basin would also provide some water quality treatment though the bioswales are intended to be the primary treatment features. The Applicant has indicated that the bioswale design would meet the area and volume requirements to satisfy the CCCWP C.3 LID design and subsequently provide the water quality and flow-control required for the OGS project. Given that OGS would discharge directly to a mitigation wetland with no outlet, Staff agrees with the Applicant's selection of treatment and flow control because this approach results in improved water quality treatment as compared to a treatment only approach.

Each of the proposed bioswales would have a trapezoidal cross-section and an outlet structure as described above. The proposed facilities are flat and would impound water up to the rim of the outlet under high flow condition before discharging downstream. A small amount of water would be discharged through low-flow orifices in the proposed outlet standpipe located 9 inches above the base of the bioswale. The design characteristics of each of the bioswales and the minimum design criteria are presented in Table 3.

The Applicant assumed a design depth and utilized the trapezoidal cross section to compute the area and volume at the assumed design depth. If the assumed design depth resulted in an area and volume greater than the minimum required, the Applicant determined that the design was adequate without further iteration or considering additional design guidelines provided for bioswales provided by CCCWP or California Stormwater Quality Association.

Table 3. Bioswale design characteristics

Bioswale	Length (feet)	Bottom Width (feet)	Assumed Depth (feet)	Top Width (at Assumed depth) (feet)	Area at Assumed Depth ($feet^2$)	Req. Min. Area ($feet^2$)	Volume at Assumed Depth ($feet^3$)	Req. Volume ($feet^3$)
#1-2	1,323	2	3.0	20	26,460	13,041	43,659	10,806
#3	187	2	2.0	14	2,618	500	2,992	415
#4	391	2	3.0	20	7,820	7,598	12,903	6,296
#5 a	265	10	2.5	25	6,625		11,594	
#5 b	120	8	3.5	29	3,480		7,770	
#5 total	385				10,105	9,910	19,364	8,211

Taken from Attachment WSQ11-1

Water Quality Treatment – Staff Review

Providing adequate water quality treatment to protect the water quality and wildlife habitat in Wetland E is one of the most important functions of the stormwater management plan for OGS. The revised stormwater system provides an improved layout from the previously submitted plan. The current layout has removed the series alignment of the Bioswales #3 with #1-2 and #5 with #4. Now the bioswales either discharge to the detention basin or the wetland directly. This modification satisfies a portion of query WSQ11 for the bioswale design.

The Applicant has provided calculations showing the use of the CCCWP IMP sizing methodology and design criteria for the four bioswales. Staff is in agreement with the methodology presented to estimate the minimum area and treatment volume required to meet treatment and flow control requirements.

Staff does not concur with the Applicant's determination of the proposed area and volume for the proposed bioswales. The Applicant has shown the area and volume for the bioswales calculated using assumed depths of between 2.0 feet and 3.5 feet. However, the intention of the bioretention criteria as shown in the C.3 Guidebook is for depths of 6 inches to 1 foot. The ratio of the treatment volume and minimum area for OGS results in a maximum average depth of 0.83 feet. By assuming depths of 2 to 3.5 feet, the Applicant has shown that they are meeting the minimum area requirement while significantly exceeding the volume requirement, which is in incorrect interpretation of the CCCWP C3 guidance.

The Applicant should perform additional iterations on the proposed design to determine the depth at which the treatment volume is captured. If the minimum area criteria is met or exceeded at this depth, the design would meet the minimum requirements in the CCCWP C3 guidelines. If the minimum area is not achieved at treatment volume depth, the proposed design should be revised such that the minimum area is achieved at the captured treatment volume. Using this approach, Staff examined the proposed design for the four bioswales to determine the area where the proposed swales contain the treatment volume as shown below in Table 4. Based on this analysis, Bioswales #1-2 and #3 can contain the treatment volume while meeting the minimum treatment area. Proposed Bioswales #4 and #5 do not have adequate area to meet the minimum area criteria at the treatment volume. In addition Bioswales #4 and #5 exceed the maximum average depth (treatment volume/minimum area).

Table 4. Bioswale Area at Treatment Volume

Bioswale	Length (feet)	Bottom Width (feet)	Depth (feet)	Top Width (feet)	Area ($feet^2$)	Req. Min. Area ($feet^2$)	Volume at Assumed Depth ($feet^3$)	Req. Volume ($feet^3$)
#1-2	1,323	2	1.35	10.1	13,362	13,041	10,806	10,806
#3	187	2	0.6	5.6	1,047	500	426	415
#4	391	2	2.01	14.06	5,497*	7,598	6,311	6,296
#5 a	265	10	1.5	19	5,035		5,764	
#5 b	120	8	1.6	17.6	2,112		2,458	
#5 total	385				7,147*	9,910	8,221	8,211

** Bioswales #4 and #5 do not meet required minimum area at the treatment volume.*

While the Applicant's initial proposed bioswale designs do not meet the required criteria, Staff believes that there is sufficient area to revise the design of the bioswales to meet the treatment and flow control requirements without significantly changing the OGS site plan. The bottom width of the swales could be widened to provide an area and volume (at a maximum design depth of one foot) that meets the minimum criteria estimated using the CCCWP IMP sizing approach. The bottom width could be widened with 3:1 side slopes for a depth of one foot. Above this treatment zone, the slopes could be steepened or even vertical to maintain the cross-sectional area required for flood control and grade constraints at the site.

Though the primary intention of the detention basin is to control peak flows to the wetland to prevent overtopping of the wetland, the detention basin can also provide water quality treatment. Staff performed a check on the water quality volume required for the project site using the unit basin storage relationships

available from the CCCWP. The OGS site would have a directly connected impervious area (DCIA) of 75 percent and a mean annual precipitation of 12.5 inches. Based on this, the unit basin storage size for 80% capture is approximately 0.036. Using the total site area of 26.3 acres, the required storage volume is approximately 0.95 acre-feet, which could be provided within the proposed detention basin.

In addition, the proposed detention basin could be significantly expanded to the north and south to include the areas where Bioswales #3 and #5B are currently proposed. The detention basin could replace the water quality function provided within those swales. An expanded detention basin adjacent to the existing mitigation wetland could offer considerable benefits related to improved water quality treatment for all site runoff. Also, it is not clear to staff why the Applicant is proposing to construct a 5 feet high berm between the existing wetland and proposed detention basin. The proposed basin could be constructed below existing grades. This would allow for flatter, more stable side slopes and would help to further expand capacity for additional water quality treatment. Thus, the water quality treatment required in Bioswales #3, #4 and #5 could easily be provided by an expanded and improved detention basin.

Staff believes that the project will be able to provide sufficient water quality treatment with some minor modifications to the currently proposed layout and design. Staff has the following recommendations to revise the current stormwater system plan:

1. Revise the bioswale cross sections to meet the IMP sizing requirements for area and volume using a maximum design depth of 1 foot.

2. Revise the low flow orifice design to limit capture and infiltration of runoff in the proposed bioswales. Ideally, the low flow orifices would pass the water quality flow rate (flow rate at 0.2 inches/hour) with a maximum of 1 foot of hydraulic head.

3. Include gravel check dams within the bioswales to limit erosion and transport of the soil mix within the bioswale during higher flow events.

4. Provide a revised analysis for the four project bioswales and details on the construction laydown bioswale.

5. Consider revising the proposed detention basin to eliminate or limit proposed berm and expand capacity to provide the water quality treatment required by undersized Bioswales #4 and #5.

6. Demonstrate that the proposed detention basin will drain the water quality volume (including volume below the low flow orifice) within 48 to 72 hours to minimize mosquito production.

REFERENCES

CCCWP. Stormwater C.3 Guidebook. September 2008.

CCCWP. Unit Basin Storage Size for 80% Capture. Accessed from website 7-27-2010. http://www.cccleanwater.org/c3-guidebook.html

Radback Energy. Response to CEC Staff Workshop Queries 3 through 1. July 2010.